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[Title of the Invention] METHOD OF AND DEVICE FOR DISPLAYING IMAGE

[Abstract]

[Problem] In a device for displaying an image carrying out active driving of organic EL elements in M columns and N rows, to extend the life of the organic EL elements.

[Means for Resolution] A driving voltage of a power source line 13 is applied to an organic EL element 12 in correspondence with a voltage held by a holding capacitor 16 to carry out light emission control of the organic EL element 12 by active driving, in which, by making the voltage held by the holding capacitor 16 in the n-th row discharged with a timing of a scanning voltage in the (n - 1)-th row to momentarily stop the driving voltage of the organic EL element 12 immediately before lighting control.

[Claims]

[Claim 1] A method of displaying an image for a device for displaying an image, wherein

the device comprises: organic EL (Electro-Luminescence) elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows (each of M and N is a specified natural number); data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; and driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the

voltage holding means of (M x N) in number, and

the method makes application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 2] A method of displaying an image for a device for displaying an image, wherein

the device comprises: organic EL elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows; data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; and driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes

to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number, and

the method makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 3] A device for displaying an image comprising:

organic EL elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows;

data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined;

scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns;

switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order;

voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and

N rows;

a pair of power source electrodes to which a specified driving voltage is always applied;

driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number; and

energizing controlling means for making application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 4] A device for displaying an image comprising:

organic EL elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows;

data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined;

scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns;

switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order;

voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows;

a pair of power source electrodes to which a specified driving voltage is always applied;

driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number; and

energizing controlling means for making a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 5] The device for displaying an image as claimed in claim 3 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row (a is a natural number smaller than N), makes the application of the driving voltage to the organic EL elements in the n-th row stop.

[Claim 6] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting

of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 7] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the application of the driving voltage to the organic EL elements in the n-th row stop and, along with this, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 8] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - b)-th row (b is an integer larger than a and smaller than N), makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 9] The device for displaying an image as claimed in claim 5 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the voltage holding means in the n-th row discharge the voltages held thereby.

[Claim 10] The device for displaying an image as claimed in claim 5 or 9 wherein the energizing controlling means, on

inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off.

[Claim 11] The device for displaying an image as claimed in any one of claims 6 to 8 wherein the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 12] The device for displaying an image as claimed in claim 8 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 13] The device for displaying an image as claimed in claim 8 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 14] The device for displaying an image as claimed in any one of claims 5 to 7 wherein

"a" is given as "a = 1", and

the energizing controlling means, on inputting of the scanning voltage to the scanning line in the N-th row, controls energizing of the organic EL elements in the first row.

[Claim 15] The device for displaying an image as claimed in any one of claims 5 to 7 wherein

"a" is given as "a = 1", and

in parallel with the scanning line in the first row, a dummy line is also provided to which a dummy scanning voltage is inputted immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the dummy line, controls energizing of the organic EL elements in the first row.

[Claim 16] The device for displaying an image as claimed in claim 8 wherein

"a" is given as "a = 1" and "b" is given as "b = 2", and

the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (N - 1)-th row, makes the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the scanning line in an N-th row, makes the reverse voltage applied to the organic EL elements in the first row, and along with this, makes the application of the driving voltage to the organic EL elements in the second row stop.

[Claim 17] The device for displaying an image as claimed

in claim 8 wherein

"a" is given as "a = 1" and "b" is given as "b = 2", and

in parallel with the scanning line in the first row, a first and second dummy lines are also provided to which dummy scanning voltages are inputted in order immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the first dummy line, makes the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the second dummy line, makes the reverse voltage applied to the organic EL elements in the first row, and along with this, makes the application of the driving voltage to the organic EL elements in the second row stop.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a method of and a device for displaying an image by which a number of organic EL elements in a two-dimensional arrangement are subjected to active driving to display an image.

[0002]

[Prior Art]

An EL display is now developed as an image displaying device which displays a dot matrix image with a number of organic EL elements in a two dimensional arrangement. Such an image

displaying device is for displaying various kinds of images in an area such as a passenger room of a vehicle where light and darkness are remarkably changed. The organic EL element is a light emitting element that spontaneously emits light and can be driven by a DC current supplied by a low voltage.

[0003] Driving modes of the organic EL element may be classified into passive and active. With the active mode, the organic EL element is continuously lighted until a displayed image is renewed to allow realization of high luminance with high efficiency. Here, as an example of a conventional image display device, an EL display in which an active driving of the organic EL element is carried out will be explained below with reference to Fig. 14 and Fig. 15. Figure 14 is a circuit diagram showing a principal part of an EL display of an example of a conventional one, and Fig. 15 is a time chart showing signal waveforms of various parts.

[0004] Here, an EL display 1 presented as an example of conventional one is provided with an organic EL element 2, and a power source line 3 and a grounding line 4 as a pair of power source electrode. To the power source line 3, a specified driving voltage is always applied, and the grounding line 4 is always maintained at "0" voltage as a reference voltage.

[0005] The organic EL element 2 is directly connected to the grounding line 4, while, is connected to the power source line 3 through a driving TFT (Thin Film Transistor) 5. The

driving TFT 5 is provided with a gate electrode. A driving voltage applied from the power source line 3 to the grounding line 4 is supplied to the organic EL element 2 in correspondence with a data voltage applied to the gate electrode.

[0006] To the gate electrode of the driving TFT 5, a holding capacitor 6 is connected as voltage holding means with an end thereof. The other end of the holding capacitor 6 is also connected to the grounding line 4. Moreover, to the holding capacitor 6 and the gate electrode of the driving TFT 5, a data line 8 is connected through a switching TFT 7 as switching means. To a gate electrode of the switching TFT 7, a scanning line 9 is connected.

[0007] To the data line 8, there is supplied a data voltage for carrying out driving control of the light emission luminance of the organic EL element 2. To the scanning line 9, there is inputted a scanning voltage for carrying out operation control of the switching TFT 7. The holding capacitor 6 functions to hold the data voltage to apply it to the gate electrode of the driving TFT 5. The switching TFT 7 functions to close and open the connection between the holding capacitor 6 and the data line 8.

[0008] In the EL display 1 shown as an example of conventional one here, the organic EL display elements of (M x N) in number is in a two-dimensional arrangement of M columns and N rows (not shown). To the organic EL elements 2 in M columns

and N rows, the data lines 8 in M columns and the scanning lines 9 in N rows are provided in a matrix connection. Here, a matrix is expressed with a one-dimensional arrangement in parallel with the vertical direction taken as a column and a one-dimensional arrangement in parallel with the horizontal direction taken as a row. This, however, only belongs to a matter of definition, so that the expression may be reversed.

[0009] In the EL display 1 with the above-explained arrangement, driving control of the organic EL elements 2 can be carried out with variable light emission luminance. In this case, as shown as (b) and (c) in Fig. 15, the scanning voltage is inputted to the scanning line 9 to make the operation of the switching TFT 7 controlled in being turned ON. In this state, as shown as (e) in the figure, a data voltage corresponding to the light emission luminance of the organic EL element 2 is supplied from the data line 8 to the holding capacitor 6 to be made held.

[0010] As shown as (d) in the figure, the data voltage held by the holding capacitor 6 is applied to the gate electrode of the driving TFT 5. Thus, as shown as (f) in the figure, the driving voltage always generated across the power source line 3 and the grounding line 4 is to be supplied to the organic EL element 2 by the driving TFT 5 so as to be in correspondence with the gate voltage thereof. Therefore, the organic EL element 2 is to emit light with luminance corresponding to the

data voltage supplied to the data line 8.

[0011] In the EL display 1, the data voltages to the data lines 8 in M columns and the scanning voltages to the scanning lines 9 in the N rows are inputted in a matrix. Therefore, the organic EL elements 2 arranged in M columns and N rows are individually lighted with luminance levels different from one another. This provides a dot matrix image with gradation thereof presented element by element.

[0012] In the case, in the EL display 1, as shown by (a) and (b) in Fig. 15, the scanning voltages are inputted to the scanning lines 9 in N rows row by row in order. Thus, when the scanning voltage is inputted, the data voltages of M in number in a series are to be inputted in order to the data lines 8 in M columns.

[0013] Moreover, as explained above, the state, in which the driving voltage is applied to the organic EL element 2 in correspondence with the data voltage held by the holding capacitor 6, is continued even though the operation of the switching TFT 7 is controlled to be in turned OFF by the scanning voltage of the scanning line 9. This makes the organic EL element 2 continue lighting controlled to provide specified luminance until the next control to enable the EL display 1 to display an image with high luminance and high contrast.

[0014]

[Problems that the Invention is to Solve]

In the EL display 1 as described above, the organic EL elements 2 arranged in M columns and N rows are made individually lighted with desired luminance levels to make it possible to display an image with multi-gradation. In particular, application of the driving voltage of the organic EL element 2 controlled at a desired voltage level can be continued until the next control. Therefore, the organic EL element 2 can be made continuously lighted to allow an image to be displayed with high luminance.

[0015] However, the EL display 1 operated by active driving causes short life of the organic EL element 2. Various kinds of reasons are considered, and it becomes clear that the organic EL element 2 characteristically becomes short life with continuous application of driving voltage with the same polarity.

[0016] For example, it is confirmed that, in an EL display with organic EL elements 2 operated by passive driving (not shown), polarity of voltages applied to the organic EL elements 2 is reversed in driving process thereof to provide the organic EL device 2 a longer life compared with the case of active driving. In the EL display with a passive mode, however, the organic EL element is not lighted with high luminance and high efficiency to make it difficult to apply the EL display to a device for which high luminance is desired.

[0017] The invention was made in view of the

above-explained problem with an object of providing a method of and a device for displaying an image which can extend the life of the organic EL element while lighting the element by an active mode driving with high luminance and high efficiency.

[0018]

[Means for Solving the Problem]

A device for displaying an image according to the invention comprises: organic EL elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows; data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements

of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number; and energizing controlling means for making application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0019] Therefore, in a method of displaying an image by a device for displaying an image according to the invention, with organic EL elements of (M x N) in number being in a two-dimensional arrangement of M columns and N rows, data voltages of (M x N) in number, with which luminance of light emission of each of the above-described (M x N) organic EL elements is individually determined, are applied to each of data lines in M columns N by N in order, and scanning voltages are inputted to scanning lines in N rows in order in synchronism with the data voltages applied to the data lines in M columns. By the scanning voltages inputted to the scanning lines in N rows in order, switching means arranged in M columns and N rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in M columns and N rows, voltage holding means arranged in M columns and N rows individually hold the data voltages of (M x N) in number applied from the data lines in M columns. Driving transistors arranged in M columns and N rows apply the driving voltage always applied to the power source electrodes to the

organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number. This makes the organic EL elements arranged in M columns and N rows subjected to active driving with individually different luminance levels to display a dot matrix multi-gradation image. However, the energizing controlling means makes application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row. Therefore, even in the case when an image with the same luminance is continuously displayed, energizing of each of the organic EL elements subjected to active driving is momentarily stopped immediately before the display control of the image.

[0020] Another device for displaying an image according to the invention comprises: organic EL elements of (M x N) in number in a two-dimensional arrangement of M columns and N rows; data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning

lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of (M x N) in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number; and energizing controlling means for making a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0021] Therefore, in a method of displaying an image by a device for displaying an image, with organic EL elements of (M x N) in number being in a two-dimensional arrangement of M columns and N rows, data voltages of (M x N) in number, with which luminance of luminescence of each of the above-described (M x N) organic EL elements is individually determined, are applied to data lines in M columns N by N in order, and scanning voltages are inputted to scanning lines in N rows in order in synchronism with the data voltages applied to the data lines

in M columns. By the scanning voltages inputted to the scanning lines in N rows in order, switching means arranged in M columns and N rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in M columns and N rows, voltage holding means arranged in M columns and N rows individually hold the data voltages of (M x N) in number applied from the data lines in M columns. Driving transistors arranged in M columns and N rows apply the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number. This makes the organic EL elements arranged in M columns and N rows subjected to active driving with individually different luminance levels to display a dot matrix multi-gradation image. However, the energizing controlling means makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row. Therefore, even in the case when an image with the same luminance is continuously displayed, the polarity of the voltage applied to each of the organic EL elements subjected to active driving is momentarily reversed immediately before the display control of the image.

[0022] In the device for displaying an image as explained

above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, can also make the application of the driving voltage to the organic EL elements in the n-th row stop. In this case, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop. Therefore, it is simply and reliably carried out with a desired timing that application of the driving voltage to the organic EL elements of M in number in an n-th row is made stopped immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0023] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, can also make the reverse voltage applied to the organic EL elements in the n-th row. In this case, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, the energizing controlling means makes the reverse voltage applied to the organic EL elements in the n-th row. Therefore, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the

n-th row.

[0024] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, can also make the application of the driving voltage to the organic EL elements in the n-th row stop and, along with this, make the reverse voltage applied to the organic EL elements in the n-th row. In this case, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop and makes the reverse voltage applied thereto. Therefore, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0025] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - b)-th row (b is an integer larger than a and smaller than N), can also make the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in an (n - a)-th row, make the reverse voltage applied to the organic EL elements in the n-th row.

[0026] In this case, on inputting of the scanning voltage to the scanning line in an (n - b)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row. Therefor, energizing of the organic EL elements with the reverse voltage is not carried out until the application of the driving voltage thereto is reliably made stopped.

[0027] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, can also make the voltage holding means in the n-th row discharge the voltages held thereby. In this case, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes the voltage holding means in the n-th row discharge the voltages held thereby. Therefore, it is realized by the operation control of the energizing controlling means that application of the driving voltage to the organic EL elements is made stopped.

[0028] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, can also make connections between the organic EL elements in the n-th row and the power source electrodes cut off. In this

case, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes connections between the organic EL elements in the n-th row and the power source electrodes cut off. Therefore, it is reliably carried out that application of the driving voltage to the organic EL elements is made stopped.

[0029] In the device for displaying an image as explained above, the energizing controlling means can also make the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. In this case, the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Therefore, for the reverse voltage for energizing the organic EL element, the scanning voltage is utilized.

[0030] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, can also make the voltage holding means in the n-th row discharge the voltages held thereby, and make the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[0031] In this case, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing

controlling means makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Therefore, by the operation control of the energizing controlling means, application of the driving voltage to the organic EL elements is made stopped and the organic EL elements with energizing current being thus stopped is energized by the scanning voltage as the reverse voltage.

[0032] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, can also make connections between the organic EL elements in the n-th row and the power source electrodes cut off, and make the scanning voltage inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[0033] In this case, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes connections between the organic EL elements in the n-th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Therefore, by the cutting off of the power source electrodes, application of the driving

voltage to the organic EL elements is made stopped and the organic EL elements with energizing current being thus stopped is energized by the scanning voltage as the reverse voltage.

[0034] In the device for displaying an image as explained above, "a" is given as "a = 1", and the energizing controlling means, on inputting of the scanning voltage to the scanning line in the N-th row, can also control energizing of the organic EL elements in the first row. In this case, since "a" is given as "a = 1", on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing controlling means carries out control of energizing of the organic EL elements and energizing of the organic EL elements in the first row is controlled on inputting of the scanning voltage to the scanning line in the N-th row of the last row.

[0035] In the device for displaying an image as explained above, "a" is given as "a = 1", and in parallel with the scanning line in the first row, a dummy line is also provided to which a dummy scanning voltage is inputted immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the dummy line, can also control energizing of the organic EL elements in the first row.

[0036] In this case, since "a" is given as "a = 1", on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing controlling means carries

out control of energizing of the organic EL elements. However, a dummy scanning voltage is inputted to the dummy line provided in parallel with the scanning line in the first row immediately before the scanning voltage for the first row. Therefore, energizing of the organic EL elements in the first row is controlled on inputting of the dummy scanning voltage to the dummy line.

[0037] In the device for displaying an image as explained above, "a" is given as "a = 1" and "b" is given as "b = 2", and the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (N - 1)-th row, can also make the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the scanning line in an N-th row, make the reverse voltage applied to the organic EL elements in the first row, and along with this, make the application of the driving voltage to the organic EL elements in the second row stop.

[0038] In this case, since "a" is given as "a = 1" and "b" is given as "b = 2", on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements. However,

the organic EL elements in the first row, on inputting of the scanning voltage to the scanning line in the (N - 1)-th row, have the application of the driving voltage thereto stopped, and on inputting of the scanning voltage to the scanning line in the N-th row, are energized by the reverse voltage. The organic EL elements in the second row, on inputting of the scanning voltage to the scanning line in an N-th row, have the application of the driving voltage thereto stopped.

[0039] In the device for displaying an image as explained above, "a" is given as "a = 1" and "b" is given as "b = 2", and in parallel with the scanning line in the first row, a first and second dummy lines are also provided to which dummy scanning voltages are inputted in order immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the first dummy line, can also make the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the second dummy line, make the reverse voltage applied to the organic EL elements in the first row, and along with this, make the application of the driving voltage to the organic EL elements in the second row stop.

[0040] In this case, since "a" is given as "a = 1" and "b" is given as "b = 2", on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage

to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements. However, to the first and second dummy lines provided in parallel with the scanning line in the first row, the first and second dummy scanning voltages are inputted immediately before the scanning voltage for the first row. Therefore, the organic EL elements in the first row, on inputting of the scanning voltage to the first dummy line, have the application of the driving voltage thereto made stopped, and on inputting of the scanning voltage to the second dummy line, are energized by the reverse voltage. The organic EL elements in the second row, on inputting of the scanning voltage to the second dummy line, have the application of the driving voltage thereto made stopped.

[0041] Incidentally, it is necessary for various means referred to in the invention only to be formed so as to realize functions thereof. For example, specialized hardware, computers with proper functions provided by programs, functions realized within computers by proper programs, and combinations thereof are allowed to be such means.

[0042]

[Mode for Carrying Out the Invention]

A first mode for carrying out the invention will be explained in the following with reference to Fig. 1 to Fig. 4. However, about the mode, same parts as those in the example

of the conventional device previously explained will be referred to with the same names and detailed explanation thereof will be omitted. Here, a matrix is also expressed with a one-dimensional arrangement in parallel with the vertical direction taken as a column and a one-dimensional arrangement in parallel with the horizontal direction taken as a row. The definition, however, is for convenience in simplifying explanation, so that reversed naming will not be rejected.

[0043] Figure 1 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as a first carrying out mode of the device for displaying an image according to the invention, Fig. 2 is a block diagram showing an entire arrangement of the EL display, Fig. 3 is a cross sectional view showing a thin film structure of an organic EL element part, and Fig. 4 is a time chart showing signal waveforms of various parts in the EL display.

[0044] As shown in Fig. 1, like one example of the conventional EL display 1, an EL display 11 as a carrying out mode is also provided with an organic EL elements 12 of (M x N) in number. As shown in Fig. 2, the organic EL elements 12 of (M x N) in number are in a two-dimensional arrangement of M columns and N rows.

[0045] Incidentally, the EL display 11 as the carrying out mode is in compliance with the so-called VGA (Video Graphics Array) standard to output a colored image display in an RGB

(Red, Green, Blue) system, in which the organic EL elements of (480 x 1980) in number are arranged in 480 columns and 1980 rows.

[0046] The EL display 11 as the carrying out mode also has a power source line 13 and a grounding line 14 as a pair of power source electrodes. The organic EL element 12 is directly connected to the grounding line 14, and is connected to the power source line 13 through a driving TFT 15 as a driving transistor.

[0047] To a gate electrode of the driving TFT 15, a holding capacitor 16 is connected as voltage holding means. The holding capacitor 16 is also connected to the grounding line 14. To the holding capacitor 16 and the gate electrode of the driving TFT 15, there is connected a drain electrode of a switching TFT 17 as switching means. The switching TFT 17 has a source electrode to which a data line 18 is connected and a gate electrode to which a scanning line 19 is connected.

[0048] The EL display 11 as the carrying out mode, however, unlike the EL display 1 as an example of the conventional one, has controlling TFTs 20 in M columns and N rows each being provided for each of the organic EL elements 12 in M columns and N rows. The controlling TFT 20 is provided as energizing controlling means for making application of a driving voltage to the organic EL elements 12 of M in number in an n-th row stop immediately before a scanning voltage with a rectangular pulse of "5.0 (V)"

is inputted to the scanning line 19 in the n-th row.

[0049] The controlling TFT 20 has a drain electrode connected to an interconnection of the holding capacitor 16 and the driving TFT 15, and a source electrode connected to the grounding line 14. However, the gate electrodes of the controlling TFTs 20 of M in number in the n-th row are connected to the scanning line 19 in an (n - 1)-th row. Thus, the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row makes the holding capacitor 16 in the n-th row discharge a voltage of "5.0 to 0.0 (V)" held thereby.

[0050] However, for the controlling TFTs 20 in the first row to which "n" becomes as "n = 1", there is no presence of the scanning line in the (n - 1)-th row. Thus, in the EL display 11 as the carrying out mode, as shown in Fig. 2, a dummy line 21 is provided in parallel with the scanning line in the first row. To the dummy line 21, there are connected gate electrodes of the controlling TFTs 20 of M in number in the first row.

[0051] Moreover, the scanning lines 19 in N rows and the dummy line 21 in one row are connected to one scanning driving circuit 22. The scanning driving circuit 22 inputs the scanning voltages of (N + 1) in number to the dummy line 21 in one row and the scanning lines 19 in N rows in order for each display of one image. Thus, a dummy scanning voltage is inputted to the dummy line 21 immediately before a scanning voltage is inputted to the scanning line 19 in the first row.

[0052] The data lines 18 in M columns are connected to one data driving circuit 23. The data driving circuit 23 applies data voltages of "5.0 to 0.0 (V)" of (M x N) in number to each of the data lines 18 in M columns in order in synchronism with each of the scanning voltages of N in number for each display of one image. Therefore, the data voltages of M in number are held by the holding capacitors of M in number in order for each one row.

[0053] Also in the EL display 11 as the carrying out mode, as shown in Fig. 2 and Fig. 3, each of the parts such as the above-explained organic EL elements 12 is formed in a laminated structure on one face of one glass substrate 30. In more detail, as shown in Fig. 3, the driving TFT 15 and the controlling TFT 20 are formed on an island 31 of p-Si layered on the face of the glass substrate 30. On the island 31, a gate oxide film 32 is layered.

[0054] In a middle portion of the gate oxide film 32, there is layered a gate electrode 33 of a metal such as aluminum onto both sides of which there are connected a source electrode 34 and a drain electrode 35, respectively. The electrodes 34 and 35 are formed integrally with the power source line 13 and the grounding line 14. The above explained structure is uniformly sealed by an insulating layer 36.

[0055] The organic EL element 12 is formed on an upper face of the insulating layer 36, on which an anode 41 of ITO

(Indium Tin Oxide) is layered. On the anode 41, a hole transporting layer 42, a light emitting layer 43, an electron transporting layer 44, and a cathode 45 of a metal are laminated in the order, with which the organic EL element 12 is formed.

[0056] The insulating layer 36 as explained above has contact holes formed at key points. By the contact holes, the anode 41 of the organic EL element 12 and the source electrode 34 of the driving TFTs 15 are connected, and a cathode 45 and the grounding line 14 are connected.

[0057] The EL display 11 as the carrying out mode is a display in which, to the organic EL elements 12 in M columns and N rows, various kinds of the lines 13, 14, ..., various kinds of the elements 15, 16, ..., and various kinds of the circuits 22, 23, ... are connected to display images in correspondence with image data externally inputted. The organic EL elements 12, each being formed with layers such as a light emitting layer 43 as shown in Fig. 3, are formed in a shape in correspondence with a picture element region of M columns and N rows in the EL display 11.

[0058] In the arrangement as described above, the EL display 11 as the carrying out mode, like one example of the conventional EL display 1, can also make the organic EL elements 12 in M columns and N rows individually emit light with desired luminance levels to display a dot matrix image with multi-gradation element by element. In particular, each of

the organic EL elements individually subjected to active driving can realize high luminance with high efficiency.

[0059] In this case, as shown in Fig. 4, with the scanning voltages inputted to the scanning lines 19 in N rows in order, the switching TFTs 17 in M columns and N rows are brought into a turned ON state row by row in order. Thus, data voltages corresponding to the light emission luminance levels of the organic EL elements 12 of M in number in the one row are individually applied to the data lines 18 in M columns.

[0060] Then, the data voltages of M in number are individually held by the holding capacitor 16 in the one row. The voltages held by the holding capacitors 16 are individually applied to the gate electrodes of the driving TFTs 15 of M in number in the one row. Thus, the driving voltage always applied to the power source line 13 is supplied to the organic EL elements 12 of M in number in the one row.

[0061] The amount of the current corresponds to the voltage applied from the holding capacitor 16 to the gate electrode of the driving TFTs 15. Hence, each of the organic EL elements 12 of M in number in the one row is to be made to emit light with a luminance level corresponding to a controlling current supplied to the data line 18. The state of the operation is maintained by the voltages held by the holding capacitors 16 even though the scanning voltages have been brought to turned OFF states.

[0062] The operation as explained above is carried out for each of the scanning lines in N rows in order. Therefore, the EL display 11 as the carrying out mode can make the organic EL elements 12 in M columns and N rows individually emit light with desired luminance levels to display a dot matrix image with gradation thereof presented element by element. In addition, the state of light emission of the organic EL element 12 is maintained by the voltage held by the holding capacitor 16 until next light emission control to realize high luminance with high efficiency.

[0063] However, in the EL display 11 as the carrying out mode, although the organic EL elements 12 are subjected to the active driving, energizing of each of the organic EL elements 12 is momentarily stopped immediately before the light emission control. Namely, when the scanning voltage is inputted to the scanning line 19 in the (n - 1)-th row, the controlling TFT 20 in the n-th row is brought into a turned ON state, connecting both ends of the holding capacitor 16 to the grounding line 14 to make energizing of the organic EL element 12 in the n-th row stop.

[0064] Therefore, in the EL display 11 as the carrying out mode, although the state of light emission of the organic EL element 12 is maintained until next light emission control by the active driving, energizing of the organic EL element 12 is momentarily stopped immediately before the light emission

control. Hence, the life of the organic EL element 12 subjected to the active driving can be extended.

[0065] In particular, the momentary stopping of the energizing of the organic EL element 12 is controlled by the scanning voltage of the scanning line 19 in the row preceding by one. Thus, the energizing of the organic EL element 12 can be reliably controlled with the optimum timing. In addition, before the scanning line 19 in the first row, the dummy line 21 is provided in parallel therewith and the dummy scanning voltage inputted to the dummy line 21 makes energizing of the organic EL element 12 stop to allow energizing of all of the organic EL elements 12 in M columns and N rows to be reliably controlled with the optimum timing.

[0066] The invention is not limited to the above mode to allow various modification therefrom within a range without departing from the gist of the invention. For example, in the above mode, an example was presented in which energizing of the organic EL elements 12 in the n-th row is made to be momentarily stopped with the timing of the scanning voltage to the scanning line 19 in the (n - 1)-th row. This can be carried out with the timing of the scanning voltage to the scanning line 19 in the (n - a)-th row. However, "a" taken as 2 or more necessitates the number of the dummy line 21 to be increased, which results in an increase in time for turning OFF the organic EL elements 12 to reduce total luminance. Therefore, it is generally best

to take "a" as "a = 1".

[0067] Moreover, in the above mode, an example was presented in which the dummy line 21 is provided in parallel with the scanning line 19 in the first row to input the dummy scanning voltage. However, it may be also possible to connect the scanning line 19 in the N-th row of the last row to the controlling TFT 20 in the first row to make energizing of the organic EL element 12 in the first row momentarily stop by the scanning voltages inputted to the scanning line 19 in the N-th row.

[0068] In the arrangement of adding the dummy line 21,it is necessary to add the dummy line 21 and an internal circuit of the scanning driving circuit 22. However, there is no necessity for providing sophisticated routing of interconnection. In an arrangement for connecting the scanning line 19 in the N-th row to the controlling TFT 20 in the first row, although there is a possibility of making the routing of interconnection sophisticated, no addition of the dummy line 21 and the internal circuit of the scanning driving circuit 22 is necessary. That is, since the above arrangements have mutually merits and demerits, when the device is put into practice, the best-suited one is well selected by considering various conditions.

[0069] Furthermore, in the above mode, there was shown an example for controlling energizing of the organic EL elements

12 in M columns and N rows with the controlling TFT 20 also arranged in M columns and N rows. It is, however, necessary only that the controlling TFTs 20 can control the organic EL elements 12 of M in number in one row for each scanning voltage. Thus, it is possible to connect, for example, each one of the controlling TFTs 20 of N in number to each one of the scanning lines 19 in N rows and the organic EL elements 12 of M in number in one row.

[0070] In the arrangement in which the controlling TFTs 20 are disposed also in M columns and N rows, despite an increase in a scale of the circuit, no sophisticated routing of interconnection is necessary. While, in the arrangement in which the controlling TFTs 20 are disposed only in N rows, although there is a possibility of causing sophisticated interconnection, a scale of the circuit can be reduced. Therefore, also in this case, the best-suited one will be practically well suitably selected.

[0071] Incidentally, in actually producing the EL display 11, thin film circuits each having the same pattern are formed in M columns and N rows. This facilitates production of the controlling TFTs 20 also arranged in M columns and N rows. While, in the arrangement in which the controlling TFTs 20 are disposed only in N rows, the controlling TFTs 20 are well suitably formed separately with positions thereof taken at an end of each row on the outside of the picture element region.

[0072] Next, a second mode for carrying out the invention will be explained in the following with reference to Fig. 5 and Fig. 6. However, in the carrying out modes hereafter, same parts as those in previous modes will be referred to with the same names and signs, and detailed explanation thereof will be omitted. Figure 5 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 6 is a time chart showing signal waveforms of various parts.

[0073] In the EL display 51 as the carrying out mode, as shown in Fig. 5, as energizing controlling means for making application of a driving voltage to the organic EL elements 12 of M in number in an n-th row stop immediately before a scanning voltage is inputted to the scanning line 19 in the n-th row, there are provided first controlling TFTs 20 in M columns and N rows, and along with this, second controlling TFTs 52 in M columns and N rows, each being provided for each of the organic EL elements 12 in M columns and N rows.

[0074] The second controlling TFT 52 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with a gate electrode and connected to both ends of the organic EL element 12 with the both ends thereof. Moreover, the second controlling TFT 52, in the first row, is also connected to the dummy line 21 with the gate electrode.

[0075] In the arrangement as described above, in the EL

display 51 as the carrying out mode, like in the EL display 11 previously explained as the first mode, energizing of the organic EL elements 12, subjected to the active driving, is also momentarily stopped immediately before the light emission control. In this case, as shown in Fig. 6, by the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, both of the first and second controlling TFTs 20 and 52 in the n-th row are brought into a turned ON state to connect both ends of the holding capacitor 16 to the grounding line 14. Along with this, both ends of the organic EL element 12 in the n-th row are made short-circuited.

[0076] This, in the EL display 51 as the carrying out mode, makes it possible to momentarily stop energizing of the organic EL elements 12 more reliably to allow the life of the organic EL element 12 subjected to active driving to be better extended. In addition, the above-explained second controlling TFT 52 can be also provided only in N rows rather than in M columns and N rows.

[0077] Following this, a third mode for carrying out the invention will be explained in the following with reference to Fig. 7 and Fig. 8. Figure 7 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 8 is a time chart showing signal waveforms of various parts.

[0078] In the EL display 61 as the carrying out mode, as

shown in Fig. 7, together with the first controlling TFTs 20 in M columns and N rows, there are controlling capacitors 62 as energizing controlling means each one being provided for each one of the organic EL elements 12 in M columns and N rows.

[0079] The controlling capacitor 62 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with one end and connected to a connection point of the organic EL element 12 and the driving TFT 15 with the other end. Moreover, the controlling capacitor 62, in the first row, is also connected to the dummy line 21 with the one end.

[0080] In the arrangement as described above, in the EL display 61 as the carrying out mode, as shown in Fig. 6, by the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, the controlling TFT 20 in the n-th row is brought into a turned ON state. Along with this, the scanning voltage is applied to the one end of the controlling capacitor 62.

[0081] Then, as shown in Fig. 8, at the other end of the controlling capacitor 62, there is generated a spike noise with reverse polarity, which is applied to the organic EL element 12 to energize it as a reverse voltage with the polarity reversed to that of the driving voltage. Therefore, in the EL display 61 as the carrying out mode, a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, can be made applied immediately before the light emission control. Hence, the life of the organic EL element 12 can be better

extended.

[0082] In the EL display 61 as the carrying out mode, in order to apply the spike noise generated at the controlling capacitor 62 as the reverse voltage to reliably energize the organic EL element 12, as shown in the figure, it is suitable to pose intervals with a specified time in the scanning voltage applied in order to the scanning lines in N rows.

[0083] In the next, a fourth mode for carrying out the invention will be explained in the following with reference to Fig. 9 and Fig. 10. Figure 9 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 10 is a time chart showing signal waveforms of various parts.

[0084] In the EL display 71 as the carrying out mode, as shown in Fig. 9, together with the first controlling TFTs 20 in M columns and N rows, there are provided third to fifth controlling TFTs 72 to 74 as energizing controlling means for each of the organic EL elements 12 in M columns and N rows.

[0085] The third controlling TFT 72 is connected to the holding capacitor 16 with the gate electrode in parallel with the driving TFT 15, connected to the grounding line 14 with the source electrode thereof, and connected to one end of the organic EL element 12 opposite to the driving TFT 15 with the drain electrode thereof. Therefore, the third controlling TFT 72, like the driving TFT 15, supplies the driving voltage,

applied from the power source line 3 to the ground line 4, to the organic EL element 12 in correspondence with the voltage held by the holding capacitor 16. Thus, discharge of the voltage held by the holding capacitor 16 brings the organic EL element 12 to be cut off from the power source line 13 and the grounding line 14.

[0086] The fourth controlling TFT 73 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with the gate electrode and the source electrode, and connected to a connection point of the organic EL element 12 and the third controlling TFT 72 with the drain electrode. The fifth controlling TFT 74 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with the gate electrode, connected to the connection point of the organic EL element 12 and the driving TFT 15 with the source electrode, and connected to the grounding line 14 with the drain electrode.

[0087] Therefore, the fourth and fifth controlling TFTs 73 and 74 in the n-th row are brought into a turned ON state on inputting of the scanning voltage to the scanning line 19 in the n-th row, and apply the scanning voltage as a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, from the organic EL element 12 to the grounding line 14.

[0088] In the arrangement as described above, in the EL display 71 as the carrying out mode, as shown in Fig. 10, by

the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, the first controlling TFT 20 in the n-th row is brought into a turned ON state to discharge the voltage held by the holding capacitor 16 in the n-th row. This brings the driving TFT 15 and the third controlling TFT 72 into a turned OFF state to make the organic EL element 12 in the n-th row float.

[0089] At the same time, by the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, the fourth and fifth controlling TFTs 73 and 74 in the n-th row are brought into a turned ON state to connect both ends of the organic EL element 12 to the scanning line 19 in the (n - 1)-th row and the grounding line 14, respectively. This makes the scanning voltage in the scanning line 19 in the (n - 1)-th row applied to the organic EL element 12 as a reverse voltage with a polarity thereof being reversed to that of the driving voltage.

[0090] Therefore, in the EL display 71 as the carrying out mode, the reverse voltage, with a polarity thereof being reversed to that of the driving voltage, can be made applied immediately before the light emission control. Hence, the life of the organic EL element 12 can be better extended. In particular, utilization of the scanning voltage, inputted to the scanning line 19, as the reverse voltage necessitates no special circuit for producing the reverse voltage, which allows the EL display 71 as the carrying out mode to apply a proper

reverse voltage with a simple structure.

[0091] It is necessary only that the fourth controlling TFT 73 in the EL display 71 according to the above mode, when the scanning voltage is inputted to the scanning line 19 in the (n - 1)-th row, can supply the scanning voltage to the organic EL element 12. Therefore, as in an EL display 82 shown in Fig. 11 as an example of variation, the fourth controlling TFT 73 can be further substituted by a diode element 82.

[0092] Subsequent to this, a fifth mode for carrying out the invention will be explained in the following with reference to Fig. 12 and Fig. 13. Figure 12 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 13 is a time chart showing signal waveforms of various parts.

[0093] In the EL display 91 as the carrying out mode, as shown in Fig. 12, a gate electrode of a first controlling TFT 20 in the n-th row is connected to a scanning line 19 in the (n - 2)-th row. Thus, the first controlling TFT 20, on inputting of the scanning voltage to the scanning line 19 in the (n - 2)-th row, makes the holding capacitor 16 discharge the voltage held thereby.

[0094] In the arrangement as described above, in the EL display 91 as the carrying out mode, as shown in Fig. 13, at the time when the scanning voltage is inputted to the scanning line 19 in the (n - 2)-th row, the voltage held by the holding

capacitor 16 is discharged to make the organic EL element 12 in the n-th row float. In such a state, on inputting of the scanning voltage to the scanning line 19 in the (n - 2)-th row, the scanning voltage energizes the organic EL element 12 as the reverse voltage.

[0095] Therefore, in the EL display 91 as the carrying out mode, application of the driving voltage to the organic EL element 12 is reliably stopped immediately before the light emission control. With the application of the driving voltage being thus completely stopped, the organic EL element 12 is energized by the reverse voltage. Therefore, in the EL display 91 as the carrying out mode, the organic EL element 12 can be reliably energized by the reverse voltage. Hence, the life of the organic EL element 12 can be better extended.

[0096]

[Advantage of the Invention]

The invention arranged as described above exhibits advantages as described in the following.

[0097] In the method of displaying an image by a device for displaying an image according to the invention, with the organic EL elements of (M x N) in number being in a two-dimensional arrangement of M columns and N rows, the data voltages of (M x N) in number, with which luminance of light emission of each of the above-described (M x N) organic EL elements is individually determined, are applied to each of the data lines

in M columns N by N in order, and the scanning voltages are inputted to the scanning lines in N rows in order in synchronism with the data voltages applied to the data lines in M columns. By the scanning voltages inputted to the scanning lines in N rows in order, the switching means arranged in M columns and N rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in M columns and N rows, the voltage holding means arranged in M columns and N rows individually hold the data voltages of (M x N) in number applied from the data lines in M columns. Then, the driving transistors arranged in M columns and N rows apply the driving voltage always applied to the power source electrodes to the organic EL elements of (M x N) in number individually in correspondence with the voltages held by the voltage holding means of (M x N) in number. This makes the organic EL elements arranged in M columns and N rows subjected to active driving with individually different luminance levels to display the dot matrix multi-gradation image. However, the energizing controlling means makes application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row. This makes, even in the case when an image with the same luminance is continuously displayed, energizing of each of the organic EL elements subjected to active driving momentarily stop immediately before

the display control of the image. Therefore, the life of the organic EL element can be made extended.

[0098] In the method of displaying an image by another device for displaying an image according to the invention, the energizing controlling means makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in the n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row. Therefore, even in the case when an image with the same luminance is continuously displayed, the polarity of the voltage applied to each of the organic EL elements subjected to active driving is momentarily reversed immediately before the display control of the image. Thus, the life of the organic EL element can be made extended.

[0099] In the device for displaying an image as explained above, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop. Because of this, it can be simply and reliably carried out with a desired timing that the application of the driving voltage to the organic EL elements of M in number in an n-th row is made stopped immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0100] Moreover, on inputting of the scanning voltage to

the scanning line in the (n - a)-th row, the energizing controlling means makes the reverse voltage applied to the organic EL elements in the n-th row. Because of this, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0101] In addition, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the application of the driving voltage to the organic EL elements in the n-th row stop and makes the reverse voltage applied thereto. Because of this, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0102] Furthermore, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row. Because of this, energizing of the organic

EL elements with the reverse voltage can not be reliably carried out until the application of the driving voltage thereto is reliably made stopped.

[0103] Moreover, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the voltage holding means in the n-th row discharge the voltages held thereby. Because of this, it is simply and reliably carried out by the operation control of the energizing controlling means that application of the driving voltage to the organic EL elements is made stopped.

[0104] Further, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off. Because of this, it is reliably carried out that application of the driving voltage to the organic EL elements is made stopped.

[0105] In addition, the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, the scanning voltage can be utilized as the reverse voltage for energizing the organic EL element to make it possible to reliably generate an adequate reverse voltage with a simple structure.

[0106] Moreover, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing

controlling means also makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, application of the driving voltage to the organic EL elements can be made stopped by the scanning voltage in the scanning line in the (n - b)-th row, and the organic EL elements with energizing current being thus stopped can be energized with the scanning voltage to the scanning line in the (n - a)-th row taken as the reverse voltage. Thus, the reverse voltage can be applied to the organic EL element with the driving voltage thereof completely stopped.

[0107] Further, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes connections between the organic EL elements in the n-th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, application of the driving voltage to the organic EL elements can be made stopped by the scanning voltage in the scanning line in the (n - b)-th row, and the organic EL elements with energizing current being thus stopped can be energized with the scanning voltage to the scanning line in the (n - a)-th row taken as the reverse voltage. Thus, the reverse voltage

can be applied to the organic EL element with the driving voltage thereof completely stopped.

[0108] Moreover, by controlling energizing of the organic EL elements in the first row with the scanning voltage to the scanning line in the N-th row of the final row, even with the arrangement in which the energizing controlling means controls energizing of the organic EL element on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing of the organic EL elements in the first row can be controlled with a proper timing with a simple arrangement.

[0109] Furthermore, the dummy scanning voltage is inputted to the dummy line provided in parallel with the scanning line in the first row immediately before the scanning voltage for the first row, and energizing of the organic EL elements in the first row is controlled on inputting of the dummy scanning voltage to the dummy line. Because of this, even with the arrangement in which the energizing controlling means controls energizing of the organic EL element on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing of the organic EL elements in the first row can be controlled with a proper timing with a simple arrangement.

[0110] In addition, the organic EL elements in the first row, on inputting of the scanning voltage to the scanning line in the (N - 1)-th row, have the application of the driving voltage thereto stopped, and on inputting of the scanning voltage to

the scanning line in the N-th row, are energized by the reverse voltage. Further, the organic EL elements in the second row, on inputting of the scanning voltage to the scanning line in an N-th row, have the application of the driving voltage thereto stopped. Because of this, even with the arrangement in which, on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements, the energizing of the organic EL elements in the first row and in the second row can be controlled with a proper timing with a simple arrangement.

[0111] Besides this, to the first and second dummy lines provided in parallel with the scanning line in the first row, the first and second dummy scanning voltages are inputted immediately before the scanning voltage in the first row. Therefore, the organic EL elements in the first row, on inputting of the scanning voltage to the first dummy line, have the application of the driving voltage thereto made stopped, and on inputting of the scanning voltage to the second dummy line, are energized by the reverse voltage. Furthermore, the organic EL elements in the second row, on inputting of the scanning voltage to the second dummy line, have the application of the driving voltage thereto made stopped. Because of this, even

with the arrangement in which, on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements, the energizing of the organic EL elements in the first row and in the second row can be controlled with a proper timing with a simple arrangement.

[Brief Description of the Drawings]

[Fig. 1] A circuit diagram showing a circuit arrangement of a principal part of an EL display as a first mode of the device for displaying an image according to the invention;

[Fig. 2] A block diagram showing an entire arrangement of the EL display;

[Fig. 3] A cross sectional view showing a thin film structure of an organic EL element part;

[Fig. 4] A time chart showing signal waveforms of various parts in the EL display;

[Fig. 5] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 6] A time chart showing signal waveforms of various parts;

[Fig. 7] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 8] A time chart showing signal waveforms of various parts;

[Fig. 9] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 10] A time chart showing signal waveforms of various parts;

[Fig. 11] A circuit diagram showing a circuit arrangement of a principal part of an EL display of an example of variation;

[Fig. 12] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 13] A time chart showing signal waveforms of various parts;

[Fig. 14] A circuit diagram showing a principal part of an EL display of an example of a conventional one; and

[Fig. 15] A time chart showing signal waveforms of various parts.

[Description of the Reference Numerals and Signs]

11, 51, 61, 71, 81, 91 EL display

12 organic EL element

13 power source line as one of a pair of power source electrodes

14 grounding line as one of a pair of power source electrodes

15 driving TFT as driving transistor

16 holding capacitor as voltage holding means

17 switching TFT as switching means

18 data line

19 scanning line

20, 52, 72 to 74 controlling TFT as energizing controlling means

21 dummy line

62 controlling capacitor as energizing controlling means

82 diode element as energizing controlling means

Fig. 1

11 EL display

12 organic EL element

13 power source line

14 grounding line

15 driving TFT

16 holding capacitor

17 switching TFT

18 data line

19 scanning line

20 controlling TFT

Fig. 2

21 dummy line

22 scanning driving circuit

23 data driving circuit

Fig. 3

13 power source line

14 grounding line

30 glass substrate

31 island

32 gate oxide film

33 gate electrode

34 source electrode

35 drain electrode

36 insulating layer

41 anode

42 hole transporting layer

43 light emitting layer

44 electron transporting layer

45 cathode

Fig. 4

(a) scanning line n - 1

(b) scanning line n

(c) controlling TFT Gate

(d) switching TFT Gate

(e) driving TFT Gate

(f) holding capacitor

(g) organic EL element

Fig. 5

52 controlling TFT

Fig. 6

(a) scanning line n - 1

(b) scanning line n

(c) first controlling TFT Gate

(d) switching TFT Gate

(e) driving TFT Gate

(f) second controlling TFT Gate

(g) holding capacitor

(h) organic EL element

Fig. 7

62 controlling capacitor

Fig. 8

(a) scanning line n - 1

(b) scanning line n

(c) EL element

Fig. 9

Fig. 10

(a) scanning line n - 1

(b) scanning line n

(c) first controlling TFT Gate

(d) switching TFT Gate

(e) third controlling TFT Gate

(f) driving TFT Gate

(g) fourth controlling TFT Gate

(h) fifth controlling TFT Gate

(i) holding capacitor

(j) organic EL element

Fig. 13

(a) scanning line n - 2

(b) scanning line n - 1

(c) scanning line n

(d) first controlling TFT Gate

(e) switching TFT Gate

(f) third controlling TFT Gate

(g) driving TFT Gate

(h) fourth controlling TFT Gate

(i) fifth controlling TFT Gate

(j) holding capacitor

(k) organic EL element

Fig. 14

1 EL display

2 EL element

3 power source line

4 grounding line

6 holding capacitor

8 data line

9 scanning line

Fig. 15

(a) scanning line n - 1

(b) scanning line n

(c) switching TFT Gate

(d) driving TFT Gate

(e) holding capacitor

(f) organic EL element